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A Method for the Production of Piston-Type Accumulators

The invention relates to a method for the production of piston-type accumulators having an accumulator housing and a separating piston, which is displaceable in the longitudinal direction in the accumulator housing, separating two working chambers from each other and which accumulator housing is sealed on each of the end sides by a cover component.

Piston-type accumulators are, in the broadest sense of the term, so-called hydraulic accumulators, which among other things serve the purpose of admitting specific volumes of a pressurized liquid (hydraulic medium) of a hydraulic system and returning these volumes to the system when required. Since the hydraulic medium is pressurized, hydraulic accumulators are treated as pressure reservoirs and must be designed for the maximum excess operating pressure, the acceptance standards of various installing countries being taken into consideration. Hydropneumatic (gas-charged) accumulators with a separating element are currently used in most hydraulic systems, a piston which separates a fluid space as working chamber from a gas space as additional working chamber serving as separating element inside the accumulator housing of the piston-type accumulator. Nitrogen is generally used as the operating gas and the gas-tight piston to a great extent permits disconnection of the gas space from the fluid space.

The fluid component is connected to the hydraulic circuit so that, as the pressure rises, the piston-type accumulator admits fluid and the gas is compressed in the process. As the pressure drops the compressed gas expands and displaces the pressurized fluid back into the hydraulic circuit. One advantage of piston-type accumulators is they can Awork@ when in any position, but preference is to be given to vertical positioning with the gas side on top, so that settling of fouling particles from the fluid on the piston seals is prevented.

Consequently, the essential components of a piston-type accumulator are an outer cylindrical tube as accumulator housing, the piston as separating element with its sealing system, and the sealing covers on the end, which as cover elements simultaneously also contain a fluid and a gas connection. Two functions are regularly assigned to the accumulator housing, specifically storage of internal pressure and ensuring control of the piston inside the accumulator housing. The cover components on the front surface sealing the interior of the accumulator housing off from the exterior are provided on the outer circumference with external threading which may be screwed into a corresponding inner threading along the free longitudinal edge over an assigned path. Production of the respective threaded connection is time-consuming; this factor correspondingly increases the production costs of the piston-type accumulator. In addition, safety measures must be taken in order to secure in its position the cover component introduced.

On the basis of this prior art as disclosed, the invention has the object of improving the disclosed manufacturing process for piston-type accumulators to the end that a reliable operation of a cover component secured in position in the accumulator housing is guaranteed while the otherwise customary threaded connections are avoided. This object is attained by a method having the characteristics specified in claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1, the cover component on one of its sides is fastened by the free longitudinal edge of the accumulator housing, which edge is for this purpose moved onto the cover component, and, the otherwise customary screw connection being avoided in the case of the respective cover component, a sort of clamping onto the free end of the accumulator housing is achieved in which the cover component is clamped at least over the free longitudinal edge of the accumulator housing after this housing has been moved onto the cover component, it being sufficient if a part of the free longitudinal edge effects the clamping in question.

In one preferred embodiment of the method claimed for the invention provision is made such that at least one of the two cover components is inserted by one side opposite the other side to come up against a stop in the interior of the accumulator housing and/or such that the respective cover component is retained in its end position by the clamping force of the longitudinal edge introduced. If a stop is provided on the inside of the accumulator housing, the cover component may be immobilized against this stop during the positioning movement of the free longitudinal edge of the accumulator housing. In addition or as an alternative, however, the possibility exists of inserting the cover component into the free end of the accumulator housing and then initiating the positioning movement of the free end of the accumulator housing. The positioning movement may be effected toward the upper side of the cover if the cover component is retained in a suitable position, but it is also conceivable that an unrestrained positioning movement may be effected for the longitudinal edge and then, in the state of readiness for operation, the cover component may be moved by the piston against the free longitudinal edge, which then effects the clamping there.

By preference provision is also made such that a shaping tool is provided for the positioning movement of the longitudinal edge of the accumulator housing, a tool which is provided with positioning bevels and positions the longitudinal edge of the accumulator housing

on the cover component in such a way that this cover component is secured in the accumulator housing as the clamping seat referred to.

In one especially preferred embodiment of the method claimed for the invention two shaping tools positioned on opposite sides carry out the fastening process for the respective end cover component in a common positioning movement to the accumulator housing, these shaping tools acting on the free longitudinal edge of the accumulator housing. It has been found to be highly advantageous for the purpose of generation of high fastening forces to position the two free ends of the cylindrical accumulator housing uniformly, the shaping tool which acts on one end of the accumulator housing being capable in addition of reliably withstanding the forces which are introduced into the accumulator housing by the other shaping tool.

Other advantageous embodiments are specified in the other dependent claims.

The method claimed for the invention will be described in detail below with reference to the drawing, in which, in the form of diagrams not drawn to scale,

FIG. 1 presents a longitudinal section of a piston-type accumulator present in the state of the art;

FIG. 2, presents a longitudinal section of the upper part of the first embodiment of a piston-type accumulator with a shaping tool positioned above it;

FIGS. 3 and 4 present a longitudinal section of the positioning of a positioning tool on the free end of the accumulator housing for the purpose of fastening the respective cover component;

FIGS. 5 and 6 a longitudinal section of the upper areas of the accumulator housing in the form of two different versions with insertion bevels positioned in the interior for introduction of the respective cover component;

FIG. 7 also presents a longitudinal section of the upper part of a second embodiment of a piston-type accumulator housing with modified cover component.

The piston-type accumulator of the prior the art shown in FIG. 1 has as accumulator housing 10 an outer cylindrical tube into which a piston 12 with its sealing system 14 on the exterior has been introduced as separating element so as to be longitudinally displaceable. Inside the accumulator housing 10 the piston 12 separates two working chambers 16, 18 from each other, one working chamber 16 serving to receive an operating gas, in particular one in the form of nitrogen, while the other working chamber 18 forms the so-called fluid space for the piston-type accumulator. The displaced position of the piston 12 and accordingly the volume percentages of gas and fluid in the working chambers 16 and 18 vary with the operating situation of the accumulator. There is mounted on the end of the accumulator housing 10 a cover component 20, 22 having a gas connection 24 for recharging with nitrogen operating gas and a fluid connection 26 for connecting the piston-type accumulator to an overall hydraulic system not shown in detail.

Each of the two cover components 20, 22 is provided with external threading 28 which may be engaged with internal threading 30 which is mounted so as to extend along the free longitudinal edge 32 and outward to the exterior. On the external circumference side the respective cover component 20, 22 is provided with a seal 34 for sealing the interior of the accumulator housing 10 from the exterior. Application of the lengths of threading 28, 30 entails

a certain production effort which makes the prior piston-type accumulators complex and expensive to produce. It is also necessary to secure each cover component 20, 22 from rotation in order to ensure its fixing in position inside the accumulator housing 10. One possible method of securing the respective cover component 20, 22 from rotation may be represented by providing a conventional adhesive seal along the threading 28, 30 or by keeping the cover component in its position by means of a conventional retention bore (with and without threading).

On the basis of this solution of the prior art the method claimed for the invention will now be described in greater detail with reference to FIGS. 2 and the following. This solution permits cost-effective creation of a reliably operating connection of cover component and the associated accumulator housing 20. For the sake of greater simplicity of presentation, only the upper end of the accumulator housing 10 is shown in FIG. 2, along with the upper cover component 20. When reference is made to these structural components below, as with the prior art embodiment shown in FIG. 1 the respective structural components are designated by the same reference numbers as in FIG. 1.

The method claimed for the invention is among other things characterized in that the respective cover component, in this instance cover component 20, is inserted by its lower side to come into contact with a stop 38 in the form of an annular surface in the interior of the accumulator housing 10, the component being secured on its opposite side 40 by the free longitudinal edge 32 of the accumulator housing 10, the longitudinal edge 32 undergoing a positioning movement to the cover component 20, as is to be explained in greater detail in what follows.

A shaping tool 42 serves to position the longitudinal edge 32 of the accumulator housing 20, this shaping tool 42 being provided with at least one positioning bevel 44 which positions the

longitudinal edge 32 on the cover component 10 so that this component is secured as a clamping seat in the accumulator housing 10 between the stop 38 and the longitudinal edge 32. For the purpose of establishing the respective clamping seat the upper side 40 of the cover component 20 is provided with a contact surface 46 which is mounted so as to taper toward the longitudinal axis 48 of the accumulator housing 10. The inclination of the respective contact surface 46 corresponds to the inclination of the positioning bevel 44 of the shaping tool 42. However, other obvious inclinations or bevels are also conceivable. As is shown in FIG. 2, the positioning direction for the shaping tool 42 is that of the longitudinal axis 48 of the accumulator housing 10 or of the piston-type accumulator as a whole.

For the sake of greater clarity of illustration the separating element in the form of the piston 12 has been omitted from FIG. 2, as has also the gas connection 24 shown in FIG. 1, which is also an integral part of the upper cover component 20. Before the clamp connection has been effected by way of the shaping tool 42, the upper free end of the accumulator housing with its upper longitudinal edge 32 has an outline as shown in FIGS. 3 to 6. The wall thickness of the longitudinal edge 32 has been reduced in comparison to the rest of the accumulator housing 10, the area of transition between the different wall thicknesses forming the stop 38 for the cover component 20. In addition, the longitudinal edge 32 is provided with a tapering insertion bevel 50, by preference on its side facing the cover component 20, the bevel being oriented outward. The respective insertion bevel 50 facilitates introduction of the cover component 20 into the free upper end of the accumulator housing 10, as will be described in greater detail below.

As is shown in FIGS. 4 and 5 in particular, the free longitudinal edge 32 may also be provided on the external circumference side with a slide bevel 52 oriented toward the free end of the accumulator housing 10. This makes it easier for the longitudinal edge 32 to effect transition from its cylindrical shape as shown in FIGS. 3 to 6 to an inclined position after being positioned, the slide bevel 52 then sliding along the positioning bevel 44 of the shaping tool 42 until the

latter is visibly mounted on the accumulator housing 10 in the direction of positioning. Once the positioning movement by the shaping tool 42 has been completed, the longitudinal edge 32 is inclined along its contact surface 46 onto the cover component 20 to form a fastening bevel and in this way secures the cover component 20 against the stop 38 inside the accumulator housing 10.

In order not to endanger the secure position of the cover component 20 in the accumulator housing 10 and also to protect the cover component 20 from introduction of harmful forces, the free longitudinal edge 32 is, as shown in FIG. 2, guided along its free end so as to project over the second side 40 of the cover component 20 positioned above. After the respective clamp connection has been secured, the shaping tool 42 is moved back away from the accumulator housing 10 and then, for example, assumes its upper position as illustrated in FIG. 2. By preference the shaping process for the respective longitudinal edge 32 of the accumulator housing 10 is effected as cold forming, but hot forming involving appropriate heating of the accumulator housing material and preferably the shaping tool 42 as well is also conceivable. A conventional easily shaped steel material is used as material for the accumulator housing 10 with its longitudinal edge 32. In order to introduce the clamping forces optimally into the cover component 20 and also to ensure optimal support for the cover component 20 in the accumulator housing 10 on the edge side provision is made such that the height of the cover component 20 is adapted to the application conditions assigned by operation of the accumulator. In the case illustrated the cover component 20 is at least twice as great as the length of the longitudinal edge 32 between its free end and a deflection point 54 from which the longitudinal edge 32 is moved to the top of the cover.

As is illustrated in FIG. 7 for a modified embodiment, the cover component 20 may nevertheless project beyond the longitudinal edge 32 of the accumulator housing 10, or, in another embodiment not shown, may end so as to be flush at the same level.

In one especially preferred embodiment (not shown) of the method claimed for the invention, the fastening process for the respective end cover component 20, 22 is carried out in a common positioning movement of two shaping tools 42 on opposite sides of the accumulator housing 10 simultaneously and with more or less equal shaping forces by acting on the respective free longitudinal edge 32 of the accumulator housing 10. It has been found that in the case of the respective shaping solution the opposite shaping tool can during shaping receive the forces of the other shaping tool such as occur during the forming process. Costly support devices may be dispensed with in this configuration on the respective opposite sides where the shaping tool 42 exerts no effect. Harmonious introduction of forces into the accumulator housing 10 without the occurrence of damaging power peaks also occur in this situation.

As is shown in FIGS. 3 and 4, the respective cover component 20, 22 may be introduced into the accumulator housing 10 up to the stop 38 in the form of an annular surface, by means of a positioning tool 56, which, as is shown in FIG. 4, encloses the free longitudinal edge 32 of the accumulator housing 10. The positioning tool 56 has for the respective introduction process a feed bevel 58 along which the cover component 20, 22 may slide on the external circumference side. Use of the positioning tool 56 permits reliable prevention of possible damage to the seal 34 of the respective cover component 20,22. In addition to the feed bevel 58 the positioning tool 56 has an admission space 60 into which the upper end of the accumulator housing 10 may be introduced so that the feed bevel 58 ends flush with the upper edge of the longitudinal edge and in addition effects uninterrupted transition to the admission area 62 for the cover component 20, 22 itself in the accumulator housing 10.

In the embodiments shown in FIGS. 5 and 6 the accumulator housing 10 is provided on the inner circumference side along its upper longitudinal edge 32 with an insertion bevel 50 which extends the length of the accumulator housing 10 outward, this resulting in a sort of slip

edge over which the respective cover component 20, 22 may also be introduced and later secured. The respective alternative may be selected if the cover seal 34 is proved to be rugged and not overly susceptible to damage.

The same reference numbers are used for the same structural parts illustrated in FIG. 7; the method employed is described only to the extent that it differs significantly from the method as presented in the foregoing. In the instance of the embodiment shown the upper cover component 20 is retained by the free longitudinal edge 32 of the accumulator housing 10 so that the upper side projects an assigned distance beyond the end of the free longitudinal edge 32. In the embodiment shown in FIG. 7 the stop 38 for the cover component 20 is provided with a bevel against which the cover component 20 leans in a stepped recess. The annular seal 34 is in turn received in the outer circumference of the recessed sectional step 64; because of the stepped arrangement illustrated of accumulator housing 10 and cover component 20, the possibility exists of machining the accumulator housing 10 as finely as possible for clean contact with the sealing ring 34 at this point and of leaving the inside of the accumulator housing 10 more or less unmachined, insofar as the delivery area for the free longitudinal edges 32 of the accumulator housing 10 is affected.

The cover components 20, 22 may accordingly be fastened with high fitting accuracy, reliably, and pressure-tightly in the accumulator housings 10 by the shaping process discussed, in the widest possible variety of embodiments, while screw connections cost-intensive in mounting, which in addition remain to be secured in this position, may be dispensed with in their entirety.